Emerald Ash Borer Biological Control Program in Illinois
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The City of Chicago, Bureau of Forestry is cooperating with the US Forest Service and the Animal and Plant Health Inspection Service, Plant Protection and Quarantine (APHIS), to release and research the use of insect predators to control the Emerald Ash Borer (EAB). The primary agency contacts are Forest Service Research Entomologist, Dr. Leah Bauer, and APHIS Bio-Control Facility Manager, Dr. Jonathan Lelito. These scientists provide program guidelines, technical direction and insects to Chicago Forestry, which in turn acts as a local agent for insect releases and data collection in Illinois. The cooperative effort is mutually beneficial in that researchers can extend their programs to multiple EAB infested areas, while Chicago and surrounding communities may ultimately benefit from insect predators reducing the overwhelming numbers of EAB.

These insect predators also known as parasitoids, are insects that feed on other insects ultimately killing their host. The selected parasitoids are host specific to EAB and are natural enemies of the beetle in its native range in China[1]. The use of living biological controls or bio-controls, constitutes an important component to Integrated Pest Management and offers an additional tool in the arsenal of management tactics to reduce beetle populations. By establishing EAB parasitoids, Chicago hopes to reduce beetle pressure on ash tree populations, increasing the efficiency of chemical controls and augmenting any natural ash tree resistance to EAB.

While several parasitoids are identified as potentially impacting EAB, Chicago Forestry is working with the three hymenopteran insects currently reared by APHIS for control of EAB. These insects include one species of egg parasitoid, *Oobius agrili*, and two species of larval parasitoid, *Tetrastichus planipennisi* and *Spathius agrili*. Although in the Hymenoptera order and classified as wasps, the insects are stingless and will not harm humans or animals.

Researchers studied all three insects to see what potential these parasitoids had for attacking other species of non-EAB insects. The results demonstrated *Tetrastichus* only parasitizes EAB, and while *Spathius* and *Oobius* did parasitize other wood-boring *Agrilus* spp., they had no significant impact. The results indicated that these three parasitoids were unlikely to have any significant effect on non-EAB insects[2].

Site Selection

Chicago Forestry began identifying release sites based upon criteria listed in the USDA *Emerald Ash Borer Biological Control Release Guidelines.* Ideally sites are "in naturally forested areas, woodlots, or wooded wetlands and riparian zones" which offer the optimal conditions for insect establishment[3]. These areas not only offer a more hospitable environment than hot city streets, typically they also have more continuous ash canopy which facilitates the parasitoids spreading into new locations.

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[1] USDA–APHIS/ARS/FS. 2010. Emerald Ash Borer, *Agrilus planipennis* (Fairmaire), Biological Control Release Guidelines. USDA–APHIS–ARS-FS, Riverdale, Maryland.
[2] *Ibid*. p. 9
[3] *Ibid*. p. 12

The site selection process intuitively seemed simple, but was not as straight forward as originally thought. Forestry initially had planned on releasing insects in areas with obvious signs of EAB: epicormic sprouting, wood pecker scaling, and "D" shaped exit holes. The idea was that releasing in heavily infested areas would guarantee the parasitoids would easily find EAB and become established. However, Dr. Bauer advised against selecting these sites as they would not endure for the duration of the study, instead the trees would most likely succumb to EAB and die or decline to the extent they become unpalatable to EAB.

Furthermore, unlike urban trees which often develop characteristic signs of EAB infestation over time, many of the upper canopy ash trees found in the forest did not have distinctive EAB symptoms until just before mortality. Often the only visible symptom seen from the forest floor was a thinning canopy. When epicormic sprouting and woodpecker scaling were beginning to show, the tree only had a year or so left before death. Beetles emerging at this time would move on to find a new healthy host tree, leaving no hosts for parasitoids. As a result, symptomatic trees with advanced beetle infestation signs did not make good release trees. During subsequent site visits as the program progressed, Forestry observed conditions consistent with Dr. Bauer's ash decline scenario. Trees with thinning crowns declined much more slowly than those already showing epicormic sprouting on the upper trunks and woodpecker scaling.

So the initial challenge was to identify release sites containing relatively healthy ash trees on the leading edge of EAB infestation, but also with two-year EAB larvae present. Healthy ash trees, while infested would ideally continue to survive for another 3-4 years and allow for research of the parasitoids. The two-year larvae are EAB larvae which do not complete their development and pupate after one season. Instead these larvae continue to feed under the bark for a 2nd year and pupate the following spring. By having two-year larvae, the parasitoids would be assured of having hosts readily available at the onset of insect release.

In order to identify large forested release sites with relatively healthy ash trees, Chicago Forestry began reviewing aerial maps and identified several forested areas in Cook County Forest Preserves. The Cook County Forest Preserve District was then contacted for permission to release parasitoids on the Forest Preserve property. Cook County had collaborated on a past bio-control program for gypsy moth with Chicago, and on learning of the parasitoid release program, immediately began recommending preserve locations with varying degrees of EAB infestation.

Forestry reviewed the recommended sites on aerial maps, considered the site relative to known EAB infested regions, and then visited each site. Before entering the site, several miles of the area surrounding each site was visually inspected with a windshield survey to confirm the degree of EAB infestation. If EAB symptoms were fairly consistently observed in the area, random suspect trees were bark scraped to confirm larvae. Once EAB larvae were confirmed, the survey moved into the Forest Preserve site to identify stands of ash trees. Ash trees typically grow in low wet areas, and there was no shortage of these areas in the Cook County Forest Preserves. Once ash trees were located, they were evaluated for condition. If the majority of the ash trees was in seemingly good condition with few or far scattered advanced symptoms of EAB, the site was selected as a

proposed release location. If the core site contained roughly over 10%- 15% ash trees with advanced symptoms of EAB with multiple epicormic sprouts ranging down the lower trunk or "D" shaped exit holes, the site was eliminated.

Forestry was also able to release in two City of Chicago parks located within residential areas to act as source points for parasitoids to spread, radiating out into the surrounding communities. One of the park sites was fairly open with managed turf areas between trees typical of a park setting. This park contained several "stands" of mature ash trees and also groupings of younger ash trees planted around the time EAB first became identified in 2002. The second park site had a nature preserve in its center, where ash constituted over 40% of the canopy.

Release Preparation

After Chicago determined proposed release sites, a pre-release site assessment was completed for submittal with the release request to APHIS. The assessment recorded details about the physical characteristics of the site, including location, size and tree composition. Next, the site locations were sent to Jeff Coath, PPQ EAB Program Supervisor for Illinois for review and approval and then forwarded on to Dr. Lelito in Brighton Michigan for final approval.

Once the release sites were approved, Forestry again visited each site to identify fourteen release trees and to collect tree condition data. These trees were the release points and their condition would be monitored throughout the study. The trees were evaluated, tagged, and GPS coordinates taken. By completing this preparation work in advance, full attention could be focused on the proper handling and releasing of parasitoids during subsequent visits.

Insect Releases

Initially, the US Forest Service Research Laboratory in E. Lansing, MI was the only source of *Oobius* and *Tetrastichus*, which they discovered in China from parasitized EAB eggs and larvae, respectively. In 2010, the APHIS Biocontrol Rearing Facility in Brighton, Michigan became fully operational and is now responsible for mass-rearing three parasitoid species for management of EAB in the U.S. . The parasitoids are carefully collected and shipped in coolers overnight to cooperators for distribution. Weather conditions can influence the operation since rain prohibits a release and hot weather can easily desiccate and kill the smaller parasitoids. Ideal release conditions are on clear days with little or no wind and with temperatures less than 85°. Even in cooler temperatures, parasitoids can not be left in vehicles or in direct sun light, because they will get too hot.

Once on site and at the release tree, the type and number of parasitoid, as labeled on the cup, is recorded. The insects are then released by holding the opened cup against the release tree, allowing the parasitoids to move to the top of the cup and fly out. Any dead insects remaining in the cup are counted by sex and recorded.

Beginning in mid-July of 2009, Chicago Forestry met on site with Dr. Bauer to begin releases at two locations: Shiller Woods at 4340 North Cumberland in Chicago, along the Des Plaines River in Cook County Forest Preserves, and also a wooded area along the

North Branch Canal of the Chicago River at 200 Isabella Street in Evanston. The Shiller woods site received *Oobius and Tetrastichus*, and while the Evanston site initially only received *Oobius, Tetrastichus* parasitoids were released during a follow-up visit in July of 2010. An additional Cook County Preserve site, Blue Beech Picnic Grove at 8700 West Higgins received *Tetrastichus* in September of 2009.

The next year in 2010, all three parasitoids *Oobius*, *Tetrastichus*, and *Spathius* were released at the research sites. In addition to providing parasitoids for research plots, APHIS sent some insects for discretionary use at additional suitable release sites. Forestry released at multiple Cook County Forest Preserve sites as well as two locations along the north branch of the Chicago River and in the Chicago Park District. The Cook County Forest Preserve sites in Chicago were at: Dan Ryan Woods 9100 South Beverly, Forest Glen Grove at 5424 North Forest Glen, and Caldwell Woods at 6200 West Devon. Additional Cook County Forest Preserve sites were: Kick-a-poo Meadows at 13800 South Halsted in Riverdale, and Midlothian Woods at 15203 Pulaski Road in Midlothian.

The north branch of the Chicago River sites were on Metropolitan Water Reclamation District of Greater Chicago property, in riparian strips along the river. One site was at 7500 North Kedzie at the corners of Chicago, Lincolnwood, and Evanston approximately 5 miles south of the original Evanston release. The other site was at 2500 West Pensicola in Chicago, in a residential neighborhood along the river. The Chicago Park District site was located at Douglas Park at 1801 South California.

Chicago Bureau of Forestry is now in its third year of releasing EAB parasitoids with three sites for 2011. Two of the sites are in Cook County Forest Preserves and one in a City Park. The Forest Preserve sites are Ottawa Trail Woods at 4400 South Harlem in Stickney, and at Thatcher Woods at 1740 North Thatcher in River Forest. The Chicago Park District location is at North Park Village, 5801 North Pulaski in the Nature Preserve.

Results

The first results were based purely upon field observations at the release sites. Returning to the first three release sites several times the following spring and summer allowed Forestry to make some basic observations. The Schiller Woods site, located along the Des Plaines River, had been selected through consultation with Dr. Bauer and was a relatively healthy looking site initially. This site didn't show much of a change in appearance or tree mortality during later site visits.

Release trees in Evanston at 200 Isabella were located in a narrow riparian strip along the North Branch Canal of the Chicago River and at the time of release, were further advanced in infestation than Shiller Woods with considerable upper trunk epicormic sprouting and crown thinning. Upon visiting the site in late summer of the following year, many of the trees at this site were observed to have increased EAB damage but were still alive. However some of the trees in the area were near dead.

Likewise, Blue Beech Picnic Grove which was also along the Des Plaines River, just over 2 miles north of the Shiller Woods site, had extensive EAB damage and tree mortality by the end of 2010. This site initially had over 30% of the ash trees with some epicormic sprouting on upper trunks and slight wood pecker scaling in addition to crown thinning.

But upon inspecting the trees the following spring, they had additional sprouting on lower trunks and heavy wood pecker activity. By fall of 2010, several trees were dead and many others in decline. However, some of the release trees standing beside dead or severely declining ash trees, did have fewer epicormic sprouts and fuller crowns, indicating parasitoids might be reducing EAB numbers and larval tunneling, if only to a small degree. Based upon the results at Blue Beech and in Evanston, future release sites were more carefully evaluated and selected to insure tree health and longevity were maximized during the study.

In March of 2011, Dr. Bauer returned to Shiller Woods and with the aid of Chicago Forestry, harvested four trees, which were taken to Michigan, to rear out insects and see if the introduced parasitoids were present. Some of the logs were peeled and yielded few EAB. To date, Dr. Bauer has identified *Tetrastichus* parasitoid emerging from one of the trees with the highest EAB density. This result meant some success in recovering one of the parasitoid species in the Shiller woods area. Neither the extent of parasitoid spread nor the level of EAB control can yet be determined.
Since the tree removal and rearing process is labor intensive and time consuming, Dr. Bauer is developing a pan trap to help survey for the larger two wasps, *Tetrastichus* and *Spathius*. The trap design and trapping protocol are currently being refined and will require diligent monitoring to be effective. However, trap installation and monitoring should prove to be less physically labor intensive than harvesting ash trees, transporting them to labs, and rearing insects. Chicago Forestry anticipates installing and monitoring traps to continue to determine parasitoid establishment. Non-destructive sampling monitoring are also being developed for recovery of *Oobius* at release sites.

Forestry will also periodically visit and monitor release sites to evaluate tree condition on both large and small ash trees, and see if parasitoids are offering visible control of EAB. Dr. Bauer indicated the parasitoids may not be able to spread and build populations fast enough to preserve the larger ash trees. However, after the initial wave of EAB passes through an area, the smaller ash which escaped initial infestation may have a better chance to resist EAB once a resident parasitoid population of *Oobius, Tetrastichus*, and *Spathius* are established.

References:

USDA–APHIS/ARS/FS. 2010. Emerald Ash Borer, *Agrilus planipennis* (Fairmaire), Biological Control Release Guidelines. USDA–APHIS–ARS-FS, Riverdale, Maryland. http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/downloads/EAB-FieldRelease-Guidelines.pdf

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